

ORIGINAL ARTICLE

Recent trends in visual impairment and blindness in the UK

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Objective: To study recent trends in the cumulative incidence of visual impairment in childhood over a 15-year period and to assess progress against WHO goals for prevention.

Design, setting and participants: Data from a population-based register of visual impairment in southern England were used to estimate cumulative incidence and trends in visual impairment (VI) and severe visual impairment/blindness (SVI/BL) for children born in 1984–1998. Causes were classified by anatomical site(s), timing of insult(s) and whether the visual impairment was potentially preventable or treatable.

Results: Of 691 eligible children, 358 (53%) had VI and 323 (47%) SVI/BL. The cumulative incidence of VI to age 12 years was 7.1 (95% CI 6.4 to 7.8) per 10 000 live births and for SVI/BL was 6.2 (95% CI 5.6 to 6.9); the incidence of both decreased significantly over time. There was an inverse relationship with gestational age and birth weight, although the risk of visual impairment associated with prematurity and low birth weight decreased substantially over time. 55% of children with VI and 77% with SVI/BL had other impairments; the proportion of associated impairments among children with VI decreased over time. 130 (19%) of the children have died, with over half dying before the age of 5.

Conclusions: There is evidence of a temporal decline in the incidence of VI and SVI/BL in births from 1984 to 1998 especially in very preterm and low birthweight infants. Early childhood mortality was high. The causes of visual impairment in UK children are numerous, complex and often part of a wider picture of childhood disability.

Visual impairment in childhood has important effects on development and can have serious economic implications for both the family and society.¹ In the long term it affects employment and many other opportunities in life. In developed countries most visual impairments in children are present from birth or early childhood and a substantial proportion of these children have other impairments and disabilities as well.^{2–3}

The prevention of avoidable visual impairment in children is one of the goals of the World Health Organization's (WHO) *Global initiative for the elimination of avoidable blindness by 2020*, known as VISION 2020.⁴ Comparative data are needed to assess progress towards this goal,⁵ but with a few exceptions such information is scarce worldwide.^{3–8} In the UK the most recent data come from the study of severe visual impairment and blindness newly diagnosed in 2000, conducted through the British Ophthalmological and British Paediatric Surveillance Units.³ The latter found a higher incidence of severe visual impairment/blindness than expected based on rates from blindness registers.^{3–6}

We report trends in the incidence of visual impairment in children born over a 15-year period from 1984, the relationship with birth weight and gestational age, the distribution of specific and potentially preventable or treatable visual impairment, and the risk of death.

METHODS

Data source

The data used came from *4Child* – Four Counties Database of Cerebral Palsy, Vision Loss and Hearing Loss in Children originally established in 1984 as the Oxford Register of Early Childhood Impairments.⁸ *4Child* is a population-based register which aims to monitor the incidence of cerebral palsy, visual impairment and hearing loss in children resident in the four English counties of Berkshire, Buckinghamshire, Oxfordshire and Northamptonshire, and to provide a platform for research relating to the three impairments.⁹ Multiple source notifications

to the register are actively sought and collection of personal identifiers enables detection of duplicate cases. Notification to the register is not mandatory and there is no direct benefit of notification to individual children in terms of receipt of developmental or rehabilitation services, although the data are used for service planning.

The definition of visual impairment used for inclusion of cases on the register is visual acuity in the better eye of 6/18 or less with spectacles or aids if worn. If visual acuity cannot be measured, a clinical assessment of the degree of visual impairment is made. Although the definition does not correspond directly with the WHO classification^{9–10} of visual impairment (<6/18 to 6/60), children with a corrected visual acuity of 6/18 to 6/60 in the better eye are for these purposes defined as having visual impairment (VI) and informally referred to as having a "moderate" impairment. Children with corrected visual acuity in the better eye of less than 6/60 or no useful vision are defined as having severe visual impairment or blindness (SVI/BL).⁹ Unilateral visual impairment is excluded. Following initial notification, information about birth weight, gestational age and plurality is collected. Further clinical information including diagnostic confirmation and the presence of other impairments is sought when the child is 3 years old and again at 5 years old. Where children are notified after the age of 5, clinical information is sought immediately. Because the *4Child* register also collects notifications of children with cerebral palsy and children with hearing loss, information about these impairments is systematically recorded in more detail compared with other impairments. However, information about other impairments which affect independent living, such as specific congenital anomalies, is also recorded when provided by clinicians. The children on *4Child* are "flagged"

Abbreviations: ONS, Office for National Statistics; SVI/BL, severe visual impairment/blindness; VI, visual impairment

for mortality with the National Health Services Central Register.

A dataset of all children with visual impairment born in the *4Child* catchment area from January 1984 to December 1998 inclusive was extracted in May 2005; current residents born outside the catchment area were excluded. About half (52%) of the children were notified to *4Child* by at least two sources and 16% by three or more; 89% were notified by age 5 and the oldest was notified at age 12. Visual acuity could not be measured for 27 children of whom 23 died before age 5. We included all 27 in the SVI/BL group on the basis of clinical or death certification information.

The diagnosis and anatomical site of the cause of the visual impairment are collected as a text description rather than pre-specified categories. We used the WHO classification to categorise the anatomical site affected and the cause according to the timing or likely timing of the visual insult.¹⁰ We extended the latter classification to include a separate category for children with cerebral palsy, global developmental delay and microcephaly since the aetiology in most of these cases is unknown and, in particular, cerebral palsy should not be ascribed to the perinatal period without clear evidence¹¹; where there was clear evidence of a cause this was included in the appropriate category. Of note, some children had multiple causes and multiple anatomical sites affected. Using the categorisation described by Rahi and Cable,³ we attempted to identify cases with potentially preventable and treatable visual impairment.

Analysis

Total and birth weight-specific cumulative incidence (risk) were calculated using annual live birth statistics provided by the Office for National Statistics (ONS) as the denominator; 95% confidence intervals (95% CIs) were estimated using the exact binomial distribution. We estimated gestational age-specific cumulative incidence using denominators provided by local child health systems since gestational age is not included in ONS data.⁸ The two-sided Cochran-Armitage test for trend was used to assess temporal trends and the χ^2 test was used to compare frequencies; $p < 0.05$ was taken as statistically significant. Risk ratios (RR) and 95% CIs were calculated using the method of Clayton and Hills.¹²

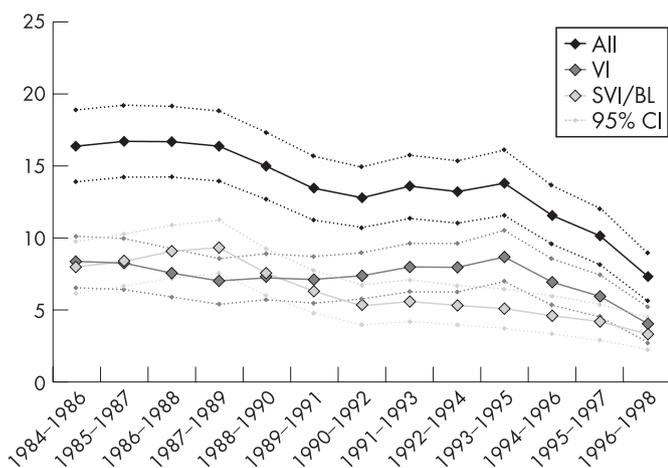


Figure 1 Cumulative incidence per 10 000 births of visual impairment (VI) and severe visual impairment/blindness (SVI/BL), 3-year rolling averages, births 1984–1998, Berkshire, Buckinghamshire, Oxfordshire and Northamptonshire.

Ethics approval

4Child operates under approvals from the Thames Valley Multicentre Research Ethics Committee and the Patient Information Advisory Group.

RESULTS

Between 1984 and 1998, there were 520 240 live births and 518 140 neonatal survivors born to the *4Child* catchment population. A total of 691 eligible children with visual impairment were notified to *4Child*. Of these, 358 (53%) had VI and 323 (47%) had SVI/BL. The total period cumulative incidence of all cases of visual impairment to 12 years of age was 13.3 (95% CI 12.3 to 14.3) per 10 000 live births; for VI it was 7.1 (95% CI 6.4 to 7.8) per 10 000, and for SVI/BL 6.2 (95% CI 5.6 to 6.9). The cumulative incidence of both VI ($p = 0.04$) and SVI/BL ($p < 0.01$) decreased significantly over time (fig 1). The proportion of children with SVI/BL decreased significantly over time ($p = 0.007$) (table 1), whereas the male:female ratio of 1.5:1 did not vary significantly over time. The risk of visual impairment in multiples was twice that of singletons (RR 2.1; 95% CI 1.5 to 2.9) and did not differ by severity. The incidence of both VI and SVI/BL was inversely associated with gestational age (fig 2) and birth weight. Compared with the most recent (1994–1998), the two earlier birth cohorts (1984–1988 and 1989–1993) had higher rates of visual impairments at all gestational ages. Although the proportion of all cases who were preterm was relatively stable at around 30% over time, the incidence of visual impairment overall decreased dramatically over time in this group.

Overall, 45% of children with VI had isolated visual impairment which varied significantly over time from 39% in the early period to 56% in the later period ($p = 0.01$) (table 2). There was no significant variation over time in the proportion (23%) of children with isolated SVI/BL ($p = 0.60$). Of note, the proportion with cerebral palsy decreased significantly from 39% to 21% among the VI cases ($p = 0.003$) but not among the SVI/BL group (45% overall) ($p = 0.86$).

The timing of the insult was ascribed to a single category of cause in 89% of all visual impairment cases, while 9% had two causes and 2% had three. The cumulative incidence of both the prenatal causes and the unknown causes associated with cerebral palsy, developmental delay and microcephaly decreased significantly over time ($p < 0.001$) (table 3). Prenatal causes were the commonest single categories for both VI (65%) and SVI/BL (52%) cases. Most of the children (68%) had only one anatomical site involved, 27% had two sites involved and 5% three sites. Cerebral/visual pathways were the most common sites of involvement, affecting 51% of VI cases and 87% of SVI/BL cases. Of the affected very preterm (<33 weeks) infants in the register, 30% had retinopathy of prematurity (ROP) and 80% had impairment of the cerebral/visual pathways. The cumulative incidences in very preterm births were 46.8 (95% CI 32.3 to 65.7) and 126.3 (95% CI 100.2 to 152.4) per 10 000 live births born at <33 weeks, respectively.

The overall incidence of both ROP and cerebral/visual pathway involvement decreased significantly over the three periods (table 4). The cumulative incidence of potentially preventable or treatable visual impairments among all births decreased over time.

A total of 130 of the 691 children have subsequently died, with the case fatality being 19% (95% CI 16% to 22%). Their age at death ranged from 4 months to 20 years (median 4 years) and 58% died before reaching their fifth birthday.

DISCUSSION

The most striking finding from our analysis is the downward temporal trend in the incidence of visual impairment. Our

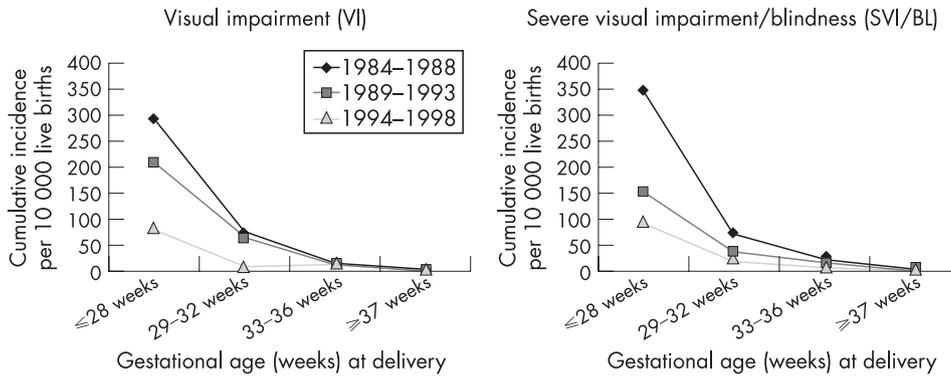


Figure 2 Gestational age-specific cumulative incidence per 10 000 live births of visual impairment (VI) and severe visual impairment/blindness (SVI/BL), births 1984–1998, Berkshire, Buckinghamshire, Oxfordshire and Northamptonshire.

results suggest that the incidence of any degree of visual impairment roughly halved for births between the mid-1980s and the late 1990s with both potentially preventable and non-preventable causes having decreased over time. Our data also indicate the risk of visual impairment associated with prematurity and low birth weight, especially in the extreme, decreased substantially over this period. Of note, a fifth of the children subsequently died, with over half dying before their fifth birthday. From our data we estimate that at least 13 in every 10 000 children born in the UK will be diagnosed with visual impairment by their 12th birthday, about six of them will be severely visually impaired or blind and many will be affected by other serious impairments. With the present number of births at approximately 720 000 per year, this represents about 950 new cases each year in the UK.

Strengths and limitations

A decline in reporting to the register might explain the decrease in incidence over time, although we think this is unlikely. Whilst always dependent on the receipt of case notifications from clinicians, *4Child* is well known to the relevant services and the notification procedures were well established and remained unchanged with respect to requirements for

notifications or resources used to ascertain cases during this period. Furthermore, had cases not been notified we would anticipate that these would, in the first instance, be the less severe, isolated cases. However, we found the incidence of both VI and SVI/BL had declined and in fact the proportion of isolated cases had increased rather than decreased over time. We do expect to receive some further notifications for children born in the later period, however, since about 90% of children are notified to the register by age 5, any underestimate is likely to be quite small. Recent comparative data come from the study by Rahi and Cable³ in 2000 and most of the children in that study were born in the same period as the children reported here. We were therefore reassured to find our cumulative incidence estimates of SVI/BL for both 5 (5.8 per 10 000) and 12 years (6.2) were highly consistent with the results of Rahi and Cable (5.3 and 5.9, respectively) and the proportion of SVI/BL cases with associated impairments (77%) was also in agreement with their findings (78%).³

We used the classification developed by Rahi and Cable³ to try to describe the children and their visual impairment in terms of potential preventability and treatability for comparison purposes and to assess the attainability of the VISION 2020 goal for a developed population. We must acknowledge that our capacity to

Table 1 Cumulative incidence of both visual impairment and severe visual impairment and blindness per 10 000 live births*, Berkshire, Buckinghamshire, Oxfordshire and Northamptonshire, 1984–1998

	Live births 1984–1988, n = 168 475		Live births 1989–1993, n = 179 181		Live births 1994–1998, n = 172 584		p Trend‡
	n (%)	CI† (95% CI)	n (%)	CI† (95% CI)	n (%)	CI† (95% CI)	
Severity							
VI¶	131 (47.1)	7.8 (6.5 to 9.2)	135 (55.8)	7.5 (6.3 to 8.9)	102 (59.6)	5.9 (4.8 to 7.2)	0.04
SVI/BL§	147 (52.9)	8.7 (7.4 to 10.3)	107 (44.2)	6.0 (4.9 to 7.2)	69 (40.4)	4.0 (3.1 to 5.1)	<0.001
Gestational age							
≤28 weeks	24 (8.6)	640.0 (414.3 to 937.3)	24 (9.9)	361.4 (232.9 to 533.0)	15 (8.8)	182.5 (102.5 to 299.1)	<0.001
29–32 weeks	22 (7.9)	153.0 (96.1 to 230.7)	19 (7.9)	102.2 (61.6 to 159.1)	7 (4.1)	37.1 (14.9 to 76.2)	0.001
33–36 weeks	33 (11.9)	43.5 (30.0 to 61.1)	26 (10.7)	30.1 (19.7 to 44.0)	24 (14.0)	27.0 (17.3 to 40.1)	0.07
≥37 weeks	199 (71.6)	12.5 (10.9 to 14.4)	173 (71.5)	10.3 (8.8 to 11.9)	125 (73.1)	7.8 (6.5 to 9.4)	<0.001
Birth weight**							
<1000 g	16 (5.8)	345.6 (198.8 to 555.1)	18 (7.4)	329.7 (196.5 to 516.0)	7 (4.1)	100.3 (40.4 to 205.5)	0.004
1000–1499 g	23 (8.3)	231.9 (147.5 to 345.9)	16 (6.6)	153.0 (87.7 to 247.2)	12 (7.1)	105.9 (54.8 to 184.3)	0.02
1500–1999 g	21 (7.5)	100.7 (62.5 to 153.5)	17 (7.0)	75.8 (44.2 to 121.0)	12 (7.1)	51.4 (26.6 to 89.6)	0.06
2000–2499 g	29 (10.4)	39.3 (26.3 to 56.4)	33 (13.7)	43.5 (29.7 to 61.3)	13 (7.7)	17.2 (9.2 to 29.4)	0.02
2500–3499 g	126 (45.3)	13.4 (11.2 to 16.0)	93 (38.4)	10.1 (8.1 to 12.4)	80 (47.4)	9.0 (7.2 to 11.2)	0.004
≥3500 g	63 (22.7)	10.0 (7.6 to 12.7)	65 (26.9)	9.3 (7.2 to 11.9)	45 (26.6)	6.4 (4.6 to 8.5)	0.001
Sex							
Female	124 (44.6)	15.1 (12.6 to 18.0)	84 (34.7)	9.6 (7.7 to 11.9)	68 (39.8)	8.1 (6.3 to 10.2)	<0.001
Male	154 (55.4)	17.8 (15.1 to 20.9)	158 (65.3)	17.2 (14.6 to 20.0)	103 (60.2)	11.7 (9.5 to 14.1)	0.001
Plurality							
Singletons	264 (95.0)	16.0 (14.1 to 18.1)	236 (97.5)	13.5 (11.8 to 15.4)	156 (91.2)	9.3 (7.9 to 10.9)	<0.001
Multiples	14 (5.0)	38.9 (21.3 to 65.3)	6 (2.5)	13.1 (4.8 to 28.6)	15 (8.8)	29.6 (16.6 to 48.8)	0.54
Total	278 (100.0)	16.5 (14.6 to 18.6)	242 (100.0)	13.5 (11.9 to 15.3)	171 (100.0)	9.9 (8.5 to 11.5)	<0.001

*Category specific denominators were used to calculate individual rates; †CI, cumulative incidence per 10 000 live births; ‡p value for the test for trend over time; ¶VI, visual impairment defined as a corrected visual acuity in the better eye of 6/18 to 6/60; §SVI/BL, severe visual impairment/blindness defined as a corrected visual acuity in the better eye of less than 6/60 or no useful vision; **birth weight was missing for 2 children born in 1994–1998.

Table 2 The presence or absence of additional impairments by the severity of visual impairment, Berkshire, Buckinghamshire, Oxfordshire and Northamptonshire, births 1984–1998

	Visual impairment (VI)†				Severe visual impairment/blindness (SVI/BL)‡			
	1984–88, n = 131	1989–93, n = 135	1994–98, n = 102	Total, n = 368	1984–88, n = 147	1989–93, n = 107	1994–98, n = 69	Total, n = 323
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Additional impairments								
Cerebral palsy (CP) without hearing loss	49 (37.4)*	40 (29.6)*	19 (18.6)*	108 (29.3)	61 (41.5)	44 (41.1)	31 (44.9)	136 (42.1)
Hearing loss with or without CP	3 (2.3)	9 (6.7)	4 (3.9)	16 (4.4)	8 (5.4)	9 (8.4)	6 (8.7)	23 (7.1)
Other impairment(s)¶	28 (21.4)	28 (20.7)	22 (21.6)	78 (21.2)	45 (30.6)	30 (28.1)	14 (20.3)	89 (27.6)
Isolated visual impairment	51 (38.9)*	58 (43.0)*	57 (55.9)*	166 (45.1)	33 (22.5)	24 (22.4)	18 (26.1)	75 (23.2)
Total	131 (100)	135 (100)	102 (100)	368 (100)	147 (100)	107 (100)	69 (100)	323 (100)

*p=0.01, statistically significant trend.

†VI, visual impairment defined as a corrected visual acuity in the better eye of 6/18 to 6/60; ‡SVI/BL, severe visual impairment/blindness defined as a corrected visual acuity in the better eye of less than 6/60 or no useful vision; ¶includes a range of impairments which affect independent living, such as specific congenital anomalies.

accurately classify children is, however, limited by the extent of the clinical information available to us. Clinical data from population registers are necessarily more limited than clinical data collected in specific time-limited studies and as a consequence some misclassification is likely to have occurred when detailed information, for example whether or not a case of bilateral congenital cataract was autosomal dominant in origin, was not provided. When uncertain we took a conservative approach and designated cases with too little information as not preventable or treatable. We take some reassurance about our data from the fact that our overall estimate of the proportion of potentially avoidable cases of visual impairment was broadly in line with that found by Rahi and Cable.³

Comparison with other studies

We have been unable to identify any other reliable source of incidence trend data in the UK for this period. Our results

appear consistent with historical prevalence estimates, although differences in the definitions of visual impairment used and the high early case fatality in our population make direct comparisons difficult.^{14–17} Elsewhere the number of registers of visual impairment is limited and we have been unable to identify published incidence trend data from them for this period.^{7 18–20} A Swedish study comparing births in 1962–76 and 1981–95 found a prevalence of VI and SVI/BL combined of 11.7 and 12.3 per 10 000, respectively, although both estimates excluded children diagnosed under the age of 4 years.⁷ Similarly in France, Arnaud *et al* found no change in prevalence in births from 1976 to 1985.²¹ In contrast, in the US Robinson *et al* found a decrease in the prevalence of congenital blindness from 1945 to 1984.²² More recently, a study in Atlanta, Georgia found a prevalence of visual impairment of 14 per 10 000 for children born in 1988 and 12 per 10 000 for children born in 1992.²³

Table 3 Cumulative incidence per 10 000 live births of grouped causal factors for visual impairment and severe visual impairment/blindness over the three periods between 1984 and 1998, births in Berkshire, Buckinghamshire, Oxfordshire and Northamptonshire

	Live births 1984–1988, n = 168 475		Live births 1989–1993, n = 179 181		Live births 1994–1998, n = 172 584	
	n* (%)	CI† (95% CI)	n* (%)	CI† (95% CI)	n* (%)	CI† (95% CI%)
Prenatal	171 (61.5)	10.2 (8.7 to 11.9)	137 (56.6)	7.6 (6.4 to 9.0)	100 (58.5)	5.8 (4.7 to 7.0)
Hereditary	78		59		43	
Hypoxia/ischaemia	0		1		0	
Infection	6		4		2	
Other	26		18		6	
Unknown	61		55		49	
Perinatal/neonatal	35 (12.6)	2.1 (1.4 to 2.9)	31 (12.8)	1.7 (1.2 to 2.4)	21 (12.3)	1.2 (0.8 to 1.9)
Hypoxia/ischaemia	4		3		2	
Infection	1		4		1	
Unspecified meningitis	4		0		2	
Other	13		7		11	
Retinopathy of prematurity	12		16		5	
Unknown	1		1		0	
Associated with‡	93 (33.5)	5.5 (4.5 to 6.8)	81 (33.5)	4.5 (3.6 to 5.6)	41 (24.0)	2.4 (1.7 to 3.2)
Cerebral palsy	77		65		31	
Developmental delay	15		16		8	
Microcephaly	1		0		2	
Childhood	23 (8.3)	1.4 (0.9 to 2.0)	10 (4.1)	0.6 (0.3 to 1.0)	12 (7.0)	0.7 (0.4 to 1.2)
Tumour	4		0		0	
Infection	4		3		0	
Hypoxia/ischaemia	9		4		3	
Non-accidental injury	0		1		5	
Accidental injury	3		1		2	
Systemic disorders	2		1		1	
Unknown	1		0		1	
Unknown	6 (2.2)	0.4 (0.1 to 0.8)	7 (2.9)	0.4 (0.2 to 0.8)	7 (4.0)	0.4 (0.2 to 0.8)
Total	278 (100.0)	16.5 (14.6 to 18.6)	242 (100.0)	13.5 (11.9 to 15.3)	171 (100.0)	9.9 (8.4 to 11.4)

*Cumulated totals exceed the total number of children as more than one causal factor may be involved; †cumulative incidence per 10 000 live births; ‡causal factor unknown but associated with cerebral palsy, developmental delay or microcephaly.

Table 4 Potentially preventable or treatable visual impairment (VI)* and severe visual impairment/blindness (SVI/BL)†, Berkshire, Buckinghamshire, Oxfordshire and Northamptonshire, births 1984–1998

	Live births 1984–1988, n = 168 475			Live births 1989–1993, n = 179 181			Live births 1994–1998, n = 172 584		
	n = 392			n = 340			n = 211		
	n	%	CI‡ (95% CI)¶	n	%	CI‡ (95% CI)¶	n	%	CI‡ (95% CI)¶
Total preventable/treatable	80	20	4.7 (3.7 to 5.8)	74	22	4.1 (3.2 to 5.1)	40	19	2.3 (1.6 to 3.0)
Preventable-definite	13		0.8 (0.4 to 1.2)	16		0.9 (0.5 to 1.3)	5		0.3 (0 to 0.5)
Retinopathy of prematurity§	12		66.2 (28.9 to 103.5)	16		63.4 (32.4 to 94.4)	5		18.5 (2.3 to 34.6)
Prenatal rubella	1			0			0		
Preventable-possible	20		1.2 (0.7 to 1.7)	21		1.2 (0.7 to 1.7)	14		0.8 (0.4 to 1.2)
Autosomal dominant diseases									
Aniridia	0			3			2		
Retinoschisis	1			0			0		
Primary optic atrophy	1			1			1		
Microphthalmus	12			10			4		
Congenital glaucoma	2			4			0		
Congenital cataract	0			1			0		
Non-accidental injury	0			1			5		
Unintentional injury	2			1			2		
Reye syndrome	2			0			0		
Treatable-definite	27		1.6 (1.0 to 2.2)	28		1.6 (1.0 to 2.1)	13		0.8 (0.3 to 1.2)
Cataract	22			18			11		
Glaucoma	2			2			1		
Uveitis	1			1			0		
Retinoblastoma	1			2			0		
Infection									
Group B streptococcal meningitis	1			3			1		
Pneumococcal meningitis	0			2			0		
Treatable-possible									
Hydrocephalus/increased intracranial pressure	20		1.2 (0.7 to 1.7)	9		0.5 (0.2 to 0.8)	8		0.5 (0.1 to 0.8)
Total not preventable or treatable	312	80	18.5 (16.5 to 20.6)	266	78	14.8 (13.1 to 16.6)	171	81	9.9 (8.4 to 11.4)
Whole globe and anterior segment	13			6			2		
Cornea (sclerocornea, corneal opacities)	3			1			1		
Other lens	3			1			1		
Uvea	1			2			2		
Retina	34		2.0 (1.3 to 2.7)	29		1.6 (1.0 to 2.2)	28		1.6 (1.0 to 2.2)
Optic nerve	32		1.9 (1.3 to 2.7)	39		2.2 (1.5 to 2.9)	21		1.2 (0.7 to 1.7)
Cerebral/visual pathway	185		11.0 (9.4 to 12.6)	149		8.3 (7.0 to 9.7)	80		4.6 (3.6 to 5.7)
Other	40		2.4 (1.6 to 3.1)	39		2.2 (1.5 to 2.9)	36		2.1 (1.4 to 2.8)

*VI, visual impairment defined as a corrected visual acuity in the better eye of 6/18 to 6/60; †SVI/BL, severe visual impairment/blindness defined as a corrected visual acuity in the better eye of less than 6/60 or no useful vision; ‡CI, cumulative incidence per 10 000 live births; ¶CI were calculated when numerators were ≥ 5 ; §denominator for CI for retinopathy of prematurity (ROP) is the number of live births before 33 weeks' gestation (no ROP after 32 weeks).

Implications of the findings

Given the relatively affluent population under surveillance, the generalisability of our findings to the whole UK population merits critical consideration. Since Rahi and Cable found that children from the most deprived socioeconomic group were over-represented in their study population,³ it seems probable that our results would under-estimate the UK population incidence to some extent. Whilst we are unable to investigate this possibility, the consistency of our findings for SVI/BL with those of Rahi and Cable³ provide some reassurance that any under-estimate is likely to be quite small. Furthermore, temporal trends in absolute risk are unlikely to be area specific, unless our population suffers from a substantially different range of causes of visual impairment than the rest of the UK. Again this seems unlikely as the distribution of causes, anatomical sites affected (data not shown) and the proportion of isolated cases were broadly similar to those found by Rahi and Cable³ in the UK and other researchers in Scandinavia.^{20–24} The longitudinal nature of our data collection and mortality information allowed us to document the risk of death associated with visual impairment. Our estimate of case fatality of one in five is probably higher than previously anticipated for an industrialised population.^{3–25}

Our findings raise the question: what has caused this decline in incidence? The combination of the wide range of anatomical sites involved and the relatively small number of cases in each diagnostic category make specific changes difficult to detect.

Whilst a decrease in preventable and potentially preventable visual impairment might be expected, we also found a decrease in visual impairment associated with causes that are not at present specifically preventable. This suggests that the decrease in incidence is related to general improvements in health and health care together with the prevention and treatment of specific conditions, for example, congenital rubella, Reye syndrome and retinopathy of prematurity.²⁶ There have been substantial specific changes in perinatal practices during this period, including the widespread introduction of antenatal steroids and surfactant, and changes in ventilation practices, which might also have had an impact, particularly on the risk of visual impairment associated with, for example, insult to the cerebral/visual pathways, especially in infants born preterm.²⁷ At the same time it should be noted that one of the largest groups showing a decline is the cerebral/visual pathway group. This group of children presents the greatest diagnostic challenge and vision testing is often limited by the children's inability to respond to vision tests, so under-notification over time must therefore remain a possibility for this group.

Conclusions

For the majority of visually impaired children in the UK, visual impairment is part of a wider picture of sensory, cognitive and/or structural impairments³ associated with limited life expectancy for a substantial proportion. Despite the wide and complex range of underlying causes and the high proportion

What is already known on this topic

- In the UK the cumulative incidence of severe visual impairment/blindness is estimated to be 5.9 per 10 000.
- The prevention of visual impairment is a priority within the World Health Organization's VISION 2020 programme.

What this study adds

- There is evidence of a temporal decline in incidence of visual impairment and severe visual impairment/blindness between the mid-1980s and the late 1990s.
- Thirteen in every 10 000 children born in the UK will be diagnosed with a visual impairment by their 12th birthday, about six of them will be severely visual impaired or blind, two thirds will be affected by other serious impairments and one in five will die during childhood.
- Despite the wide and complex range of underlying causes, the decrease in the incidence of all causes of visual impairment suggests that the goal of VISION 2020 may yet be realised for children in the developed world.

of cases which are not potentially preventable at present, the decline in incidence we have observed provides some hope that the goal of VISION 2020 may yet be realised for children living in the industrialised world.

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